TO ALL WHOM IT MAY CONCERN

Be it known that we, Heinz Gernhardt , residing at Kirchgraben 9, 37281 Wanfried, Germany, citizen of Germany; Helmut Rabe, residing at Weinbergstr. 68, 37287 Wehretal, Germany, citizen of Germany; Konrad Winkler, residing at Im Biertal 20, 37297 Berkatal 1, Germany, citizen of Germany; Jürgen Rom, residing at Bahnhofstr. 5, 37269 Eschwege; Germany, citizen of Germany and Torsten Kaczorowski, residing at Am Gemeinschaftshaus 1, 34355 Staufenberg, Germany, citizen of Germany, have invented a

WINDING MACHINE

of which the following is a specification.

WINDING MACHINE

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of co-pending German Patent Application No. 100 46 844 entitled "Spulmaschine für insbesondere empfindliches Spulgut", filed on September 20, 2000.

FIELD OF THE INVENTION

The present invention generally relates to a winding machine for winding up bobbin material arriving from a feeding apparatus. The winding machine includes a winding spindle being designed and arranged to be rotated by a drive and a unit for determining a signal which is proportional to the tension of the bobbin material.

BACKGROUND OF THE INVENTION

In many cases, the feeding apparatus which delivers the material to be wound up is not a structural component of the winding machine, but it is arranged in the end portion of a producing apparatus, for example a spinning apparatus, a finishing apparatus or the like being located upstream of the winding machine. However, there may also be a special arriving portion including guiding rollers which is located at the winding machine. Especially, the bobbin material may be sensitive material as, for example, yarn or tape. The bobbin material may be made of carbon fibers or glass fibers which are sensitive with respect to bending or friction. A plurality of changes concerning the direction of movement of the bobbin material and great angles of the bobbin being surrounded by the bobbin material at small radiuses may harm the bobbin material to an unacceptable extent. Such changing bending loads of the bobbin material are typical of known dancer arm arrangements in known winding machines.

A winding machine is known from *German Patent No. 37 23 593 C1*. The known winding machine includes a winding spindle which is driven by a controllable drive. A bobbin is located on the winding spindle, the bobbin carrying the bobbin material to be wound up by the machine. The bobbin material is put on the bobbin in a traversing manner by a traversing apparatus or a different yarn guiding apparatus. A dancer device is arranged upstream of the traversing apparatus, the dancer device determining a signal which is proportional to the tension prevailing in the bobbin material (in other words: the tractive force subjecting the material). The signal is used to control the drive of the winding spindle. The known dancer arm arrangement further includes two stationary deflection rollers between which the dancer arm is arranged. The bobbin material surrounds the three rollers in a way of a lifting block assembly. A change of the tension of the yarn effects a movement of the dancer arm. The movement of the dancer arm is determined with respect to its value and its direction. The signal is used as the manipulated variable in the control loop for the control of the drive of the winding spindle. The engine of the drive is influenced in a way that the tension in the bobbin material returns to its former value. The tension in the bobbin material is produced by the dancer arm. For this purpose, the dancer arm is subjected by the force of a spring and/or by a weight. The tension produced in the bobbin material in this way has to be compensated by the engine of the drive of the winding spindle during the winding process. The torque being transmitted to the winding spindle by the engine of the drive does not depend from the control tension of the motor and from the number of rotations corresponding to the motor diagram. A torque control is used in the known machine. The number of rotations of the winding spindle is independent from the velocity of the arriving bobbin material and from the diameter of the material being wound up on the winding spindle.

A winding machine for yarn arriving at constant velocity is known from *European Patent No. 0 712 374 B1*. The known winding machine includes a traversing apparatus for

moving the yarn back and forth in a direction transverse to its main direction of movement. The known machine includes a winding spindle being driven by a motor. A dancer arm device includes two stationary deflection rollers and a deflection roller being located on the dancer arm. The dancer arm device is used to determine a signal which is proportional to the tension in the bobbin material. The bobbin material has to contact and surround a plurality of deflection rollers at least at partially substantial surrounding angles. Consequently, the bobbin material is subjected to substantial bending loads and also to changing bending loads in combination with respective friction forces. Especially in case of sensitive bobbin material being used, the bobbin material may be harmed or even destroyed.

An apparatus for measuring the tension of moving yarn is known from *German Patent No. 29 05 713 C2*. The known apparatus includes fixed yarn guiding devices which ensure a straight movement of the yarn. The yarn passes a feeding apparatus, a first stationary head yarn guide, other prearranged units, a second stationary yarn guide, a traversing apparatus and, finally, a winding spindle on which the yarn is being wound up. A force transmitting device and a yarn excursion device is associated with the two fixed guiding devices. The force transmitting device includes a contact surface for the yarn which gets in frictional contact with the yarn to deflect an arm in response to the yarn excursion device. The tension of the yarn at maximum excursion and in the zero crossing of the traversing apparatus is measured by an extensometer strip device. The known unit for determining the tension in the bobbin material includes at least two stationary guiding devices. The bobbin material is subjected to substantial friction several times which has negative effects in case of sensitive bobbin material being used.

SUMMARY OF THE INVENTION

The present invention relates to a winding machine for winding up bobbin material arriving from a feeding apparatus. The winding machine includes a winding spindle being

designed and arranged to be rotated by a drive. A unit serves to determine a signal which is approximately proportional to the tension of the bobbin material. The unit includes an arm being designed and arranged to be movable to a limited extent and only one roller being arranged at the arm. The only one roller is designed and arranged to guide the bobbin material to contact the feeding apparatus and the roller without contacting other elements in between.

The present invention also relates to a winding machine for winding up bobbin material arriving from a plurality of feeding apparatuses. The winding machine includes a plurality of winding spindles each being designed and arranged to be rotated by a drive. A plurality of traversing apparatuses each are designed and arranged to cooperate with one of the winding spindles to wind up the bobbin material. A plurality of units each serves to determine a signal which is approximately proportional to the tension of the bobbin material. Each of the units includes an arm being designed and arranged to be movable to a limited extent and only one roller being arranged at the arm. The only one roller is designed and arranged to guide the bobbin material to contact the respective feeding apparatus and the respective roller without contacting other elements in between.

With the novel winding machine, it is possible to control a signal which is approximately proportional to the tension in the bobbin material to control the drive of the winding machine in a way to treat the bobbin material very carefully.

The novel winding machine or winding apparatus includes only one roller instead of three deflection rollers as known in the prior art. With this one single roller, the tension in the bobbin material is determined by the movement of the roller. In this way, a signal is produced which has an influence on the engine of the drive driving the winding spindle by the control unit. This one single roller is supported on a movable arm or a bar. Especially, the arm is supported to be pivotable or bendable. The movement of the arm is limited to a small range which is substantially less than the one during the movement of a dancer arm as

know in the prior art. The one single roller will still be surrounded by the bobbin material. However, it is possible to increase the bending radius by increasing the diameter of the one single roller to bend the bobbin material even more gentle and only in one direction at the roller. The two stationary deflection rollers known in the prior art are not needed in the novel winding machine. Their functions are fulfilled by different elements. The one single roller is arranged adjacent to the end of the feeding apparatus and the traversing apparatus. This means that no further deflection rollers are located between these two aforementioned elements. In the prior art, the tension in the bobbin material is produced between the two deflection rollers. In the novel winding machine, the tension in the bobbin material is produced between the one single roller and the winding spindle. The tension in the bobbin material is no longer produced by a dancer arm, but by the drive of the winding spindle. The engine or the motor of the drive of the winding spindle does not only compensate changes concerning the tension in the bobbin material, but it determines the tension in the bobbin material. The bobbin material moves on from the one single roller directly into the traversing apparatus. In this way, the traversing triangle is advantageously increased. The unit or the device for determining a signal which is approximately proportional to the tension in the bobbin material only needs to include a comparatively small number of components, it is compact and it may be produced at low costs. Without having to use additional mechanical components, as for example deflection rollers, it is possible to produce different characteristics of tension curves during a winding travel. The reason for this effect is the fact that the tension of the yarn or of a different bobbin material is only produced by the motor of the drive of the winding spindle. For example, reducing, increasing or constant tension values may be used in the form of software tables. These values may be easily and reproducibly used. Due to the fact that the bobbin material only surrounds one single roller, the bending load subjecting the bobbin material and friction forces are substantially reduced. The movement of the one single roller being arranged at the free end of the arm preferably

has a value of less than approximately 1 mm. Preferably, the value may only be approximately a few 1/10 mm. Consequently, the surrounding angle of the bobbin material at the one single roller does not substantially change, and the geometry of the arriving bobbin material remains substantially constant during the entire winding travel.

The arm may include a bending bar and the unit may include at least one sensor for sensing deflection of the bending bar. There also is the possibility of directly designing the arm as a bending bar in a way that the arm is only supported at one side and the bending forces are applied by the bobbin material moving over the one single roller. However, it is also possible that the arm only functions as a lever arm and that it is operatively connected to a bending bar which is bent by the lever arm. In this way, it is possible to intentionally enlarge the lever arm in case of respective structural conditions. The bending bar includes a sensor for sensing the deflection. The sensor may be directly arranged on the bending bar, or it may be operatively connected to the bending bar. For example, the sensor may include extensometer strips. However, force sensors, way sensors and the like may also be used. The respective sensor may include an electronic unit with which the deflection is transformed to an electric signal, especially to an electric potential. The combination of the sensor and the electronic unit for evaluation purposes allows for a small, compact design.

The arm may also be designed and arranged as a scale beam, and the unit may include at least one sensor for sensing the force of the bobbin material which subjects the one roller. The scale beam may also be designed as a control lever. It has a substantially stiff design, and it is supported approximately in its middle portion or outside its middle portion to transmit the force being applied onto the one single roller by the bobbin material to the sensor. The sensor may include extensometer strips, force sensors or the like.

However, the preferred embodiment of the arm is the one with a bending bar including extensometer strips. It is possible without problems to fix the bending bar at its one end at the supporting structure of the winding machine, to arrange the extensometer

strips approximately in the middle portion of the arm and to arrange the one roller at the free end of the arm. It makes sense to arrange the extensometer strips on the bending bar in association with the bending plane of the bending bar.

The bending bar may have a nominal bending portion, and the extensometer strips may be arranged in the nominal bending portion. Such a nominal or desired bending portion may be designed as a weakened portion of the bending bar to improve elastic bending deformation at the place where the extensometer strips are arranged. Usually, the bending bar has a cylindrical design. In this case, the nominal bending portion may include flattened, plain surfaces on which the extensometer strips may be easily and effectively placed.

The unit may further include a tubular housing including a plurality of adjustable stops, and the bending bar may be arranged in the tubular housing. The stops may be designed and arranged to limit deflection or movement of the bending bar in the tubular housing. For example, the adjustable stops may be designed as adjustable screws. The tubular housing also serves to protect the bending bar, the sensors and the electronic unit.

In case the winding machine includes a plurality of winding heads each including a winding spindle and a traversing apparatus, the units each including one single roller and together being arranged at a separate machine unit may be arranged at a comparatively great distance with respect to the traversing apparatus of each winding head such that the traversing triangle gets especially long and the variations concerning tension in the bobbin material resulting from the winding process are reduced.

Other features and advantages of the present invention will become apparent to one with skill in the art upon examination of the following drawings and the detailed description. It is intended that all such additional features and advantages be included herein within the scope of the present invention, as defined by the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention can be better understood with reference to the following drawings. The components in the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the present invention. In the drawings, like reference numerals designate corresponding parts throughout the several views.

Fig. 1 is a schematic side view of the novel winding machine.

Fig. 2 is a sectional view through the sensor according to line II-II of Fig. 1.

Fig. 3 is a similar view as Fig. 1, but it illustrates a novel winding machine including five winding spindles.

Fig. 4 is a similar view as Fig. 2, but it illustrates a sensor including a scale beam.

DETAILED DESCRIPTION

Referring now in greater detail to the drawings, **Fig. 1** illustrates a novel winding machine 1 including a supporting structure 2 carrying a front plate 3. A winding spindle 4 is rotatably supported in the front plate 3. The winding spindle 4 extends through the front plate 2, and it freely ends towards the outside. The winding spindle 4 is driven by a drive including an engine. The drive is not illustrated to simplify understanding of the drawing. The drive may a conventional one as it is used in the field of winding machines. The winding spindle 4 is supported by a bearing 5 to be pivotable to a certain limited extend. An elongated hole 6 is located in the front plate 3 to allow for the pivotal movement. A bobbin 7 is put on the winding spindle 4. During the winding process, the bobbin material 8 is wound up on the bobbin 7. For example, the bobbin material 8 may be yarn or tape. The continuous lines illustrate the beginning of the winding process, meaning the beginning of the winding travel of the material with respect to the bobbin 7 and to the spindle 4, respectively. The position of the winding spindle 4 including the wound up bobbin material 8 at the end of the winding travel is illustrated by the broken line with two dots.

A rotatable contact roller 9 is supported in a region of the front plate 3 in association with the winding spindle 4. The rotatable contact roller 9 is stationary. At the beginning of the winding travel, the bobbin 7 being detachably located on the winding spindle 4 contacts the circumference of the contact roller 9. During the winding travel, the surface of the wound up material of the bobbin material 8 contacts the contact roller 9. A traversing apparatus 10 is associated with the contact roller 9 and with the winding spindle 4. With the traversing apparatus 10, the bobbin material 8 is placed on the circumference of the bobbin 7 and on the already wound up bobbin material 8, respectively, over the length of the bobbin 7. The function of the traversing apparatus 10 is well known by a person with skill in the art.

The bobbin material 8 is fed to the winding machine 1 by a feeding apparatus 11. In the illustrated exemplary embodiment, the feeding apparatus 11 is not a component of the winding machine 1. Instead, it is located at the end of a producing unit for the bobbin material 8 with which the bobbin material 8 is continuously fed to the winding machine 1. However, it is also possible to arrange the feeding apparatus 11 in the region of the winding machine 1. In the illustrated exemplary embodiment, the feeding apparatus 11 includes two rollers which guide the bobbin material 8 and with which the bobbin material 8 is guided without having to change its direction of movement.

A unit 14 for determining a signal which is proportional to the tension of the bobbin material 8 is arranged at a separate machine unit 13 being supported on the supporting structure 2. The tension of the bobbin material or the tension prevailing in the bobbin material is to be understood as the tension resulting from pulling forces subjecting the material. The unit 14 serves to control the drive of the winding spindle 4. The unit 14 includes an arm 15 having the design of a cylinder-like axle. The arm 15 at its one end facing the machine unit 13 is fixedly connected, and at its freely protruding end, it carries a roller 16 over which the bobbin material 8 is guided. The arm 15 may also be called a cantilever arm. The roller 16 is the only roller and the only place at which the moving

direction of the bobbin material 8 changes between the feeding apparatus 11 and the traversing apparatus 10. The arm 15 with the roller 16 is arranged with respect to the feeding apparatus 11 and the traversing apparatus 10 such that the bobbin material 8 surrounds the roller 16 at a respective surrounding angle. The roller 16 at the arm 15 is supported to be freely rotatable to sensitively change the direction of movement of the bobbin material 8. The bobbin material 8 is subjected to a bending load. However, compared to usual dancer arm arrangements known in the art, there only is a bending effect towards one side, but not an alternate bending effect. Additionally, the diameter of the roller 16 may be chosen to be comparatively great to further reduce the bending load. During the winding travel, meaning the movement of the bobbin material 8 over the length of the bobbin 7, the bobbin material 8 deflects the arm 15 with the roller 16 being located thereon in the direction of arrow 17. The direction of the arrow 17 is the bisecting between the bobbin material 8 arriving at the roller 16 and leaving the roller 16.

The novel unit 14 with the roller 16 replaces dancer arm arrangements known in the prior art which include two stationary deflecting rollers and one movable roller being located on the dancer arm. It is to be seen from Fig. 1 that the novel winding apparatus 1 does not include the two deflecting rollers as known from the prior art, and that the bobbin material 8 stays free from alternate bending forces. The arrangement of the novel unit 14 on a separate machine unit 13 allows for the possibility of choosing the distance between the traversing apparatus 10 and the unit 14 desirably great to attain a great traversing triangle. However, it is also possible to arrange the unit 14 in a different region of the supporting structure 2.

It is to be seen from Fig. 1 that the unit 14 for determining a signal which is approximately proportional to the tension in the bobbin material 8 to control the drive of the winding spindle 4 works different than known prior art devices. During use of a known dancer arm, the tension in the bobbin material 8 is produced by the dancer arm being

subjected by springs, weights or the like, and the engine of the drive of the winding spindle only compensates variations of the tension. In the novel winding machine 1, the application of the tension in the bobbin material is exclusively produced by the engine of the drive of the winding spindle 4. The only roller 16 of the novel winding machine 1 also fulfils the functions of the two deflection rollers of prior art devices. In prior art winding machines, the tension in the bobbin material is produced between the two deflection rollers. In the novel winding machine 1, the tension in the bobbin material 8 is produced between the winding spindle 4 and the roller 16. In prior art winding machines, the traversing triangle is located between the last deflection roller being located upstream of the traversing apparatus and the dancer arm arrangement and the traversing apparatus. In the novel winding machine 1, the traversing triangle is located between the only one roller 16 and the traversing apparatus 10.

Fig. 2 illustrates a section according to line II-II in Fig. 1 taking into account the direction of the arrow 17. Fig. 2 shows the novel unit 14 in greater detail. The unit 14 includes the cylinder-like arm 15 in the form of a cantilever. In the illustrated exemplary embodiment, the arm 15 has the form of a bending bar 18. The bending bar or beam 18 at its one end 19 is supported in a tubular housing 20. The tubular housing 20 is supported at the machine unit 13. In this way, the one end 20 of the bending bar 18 is fixedly supported in a way that the other end 21 of the bending bar 18 freely protrudes or cantilevers. The roller 16 in the region of this end 21 is supported to be freely rotatable. The bending bar 18 in its middle portion includes a desired bending portion 22. The desired or nominal bending portion 22 is formed by flattened portions and by tapered portions of the bending bar 18. At this place, the bending bar 18 includes a plate-like portion 23 having plane surfaces on which, for example, extensometer strips 24 are located. The extensometer strips 24 form part of a sensor 25 for determining the deflection of the bending bar 18 in response to the tension in the bobbin material 8. An electronic unit 26 is located in the region of the end 19 of the bending bar 18, or at least inside the tubular housing 20. The electric signal

corresponding to the deflection of the bending bar 18 is sent to the control unit (not shown) for the drive of the winding spindle 4 by the electronic unit 26 and a cable 27.

The tubular housing 20 includes adjustable stops 28 to limit the maximum deflection of the bending bar 18 in the direction of the arrow 17. The adjustable stops 28 may be designed as adjustment screws. Furthermore, a seal 29 is located in the front end portion of the tubular housing 20. The seal 29 prevents dust and impurities from entering the interior of the tubular housing 20.

Fig. 3 illustrates another exemplary embodiment of the novel winding machine 1 including five winding heads 30 being located on the supporting structure 2. Each winding head 30 has the design as described with respect to Fig. 1. In the illustrated exemplary embodiment, there is a separate machine unit 13 on which the units 14 each being associated with a winding head 30 are located. The respective traversing triangles have different sizes. However, this does not have a negative effect since even the smallest traversing triangle has a substantial length such that changes concerning tension in the bobbin material 8 due to the winding process are neglectable. These changes concerning tension are so small that they are dampened by the control unit for the drive of the winding spindle 4 not reacting responsive to these changes.

Fig. 4 illustrates another exemplary embodiment of the novel unit or device 14. The illustration of Fig. 4 is similar to the one of Fig. 2. In the illustrated embodiment, the arm 15 is designed as a scale being 31. The scale being or balance arm 31 is a stiff component which is pivotal to a limited extent. For example, it may be pivotal about the bearing 32 being located in its middle portion. In the illustrated embodiment, the respective sensor 25 is designed as a force sensor 33, and it is located inside the machine unit 13. The force sensor 33 determines the force of the scale being 31 being applied onto the roller 16 by the bobbin material 8 during the winding travel. The force is determined at the place where the force sensor 33 is located.

Many variations and modifications may be made to the preferred embodiments of the invention without departing substantially from the spirit and principles of the invention. All such modifications and variations are intended to be included herein within the scope of the present invention, as defined by the following claims.